Estimation of Soil Erosion in Burned Forest Areas Resulting from the Cerro Grande Fire

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Introduction

The East Jemez Region has experienced two major wildfires in the past five years, as well as the recent Cerro Grande Fire in 2000. The recurrence of broad-scale wildfires in this region has been estimated at one every ten years. To address this potential hazard, the Environment, Safety and Health Division’s Technology Development, Evaluation and Application (TDEA) program has provided funding for “A Wildfire Behavior Model for the Los Alamos Region and an Evaluation of Options for Mitigating Fire Hazards.” The primary objective of the Wildfire TDEA project is to model fire behavior in the Los Alamos National Laboratory (LANL) region and develop actions to mitigate potential hazards.

A second objective of the Wildfire TDEA project is to estimate the risk of wildfire-induced soil erosion in the LANL region. Post-fire soil erosion and storm water runoff can result in contaminant transport and flooding of downstream facilities. Identification of potential problem areas will allow us to design and implement mitigation actions to protect our environment and facilities.

We are comparing two methods used to estimate wildfire-induced surface soil erosion hazards. The first is the method used by the Interagency Burned Area Rehabilitation (BAER) Team on the Cerro Grande Fire. In this method, pre-fire Universal Soil Loss Equation (USLE) estimates of soil loss, published in the Terrestrial Ecosystem Surveys of the Santa Fe National Forest, were multiplied by five factors to account for burn severity and hydrophobic soils to obtain post-fire soil erosion estimates. The second method (Enhanced USLE Approach) involved making estimates of soil erosion that incorporated multiple precipitation zones and estimates of changes in ground and canopy cover.

Methods

Using the enhanced USLE Approach, we estimated several categories of USLE Rainfall Runoff (R) and Cropping Management (C) Factors. Since annual precipitation ranges from 13 to 32 inches along the elevation gradient in the Los Alamos Vicinity, we derived corresponding R Factors that ranged from 35 to 128 (Figure 1).

We quantified, via regression analysis, relationships between C Factors and ground and canopy cover previously published in the USDA literature (Figure 2). We then developed a C Factor data layer for GIS for each of the seven habitat types in the Cerro Grande Fire area using pre-fire field data for ground and canopy cover (Figure 3). To assess the effects of the Cerro Grande Fire on these relationships, we then assumed that the following reduction in ground and canopy cover occurred for each of the three relative burn severity categories and developed a data layer for this GIS coverage (Figure 4)

•High severity: 95% reduction
•Moderate severity: 50% reduction
•Low/Unburned severity: 5% reduction

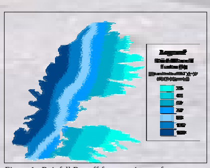


Figure 1. Rainfall Runoff factor estimates for Enhanced USLE Approach

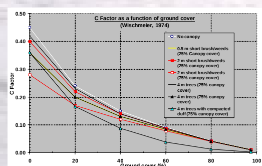


Figure 2. Pre-fire cover Management Factor estimates for Enhanced USLE Approach

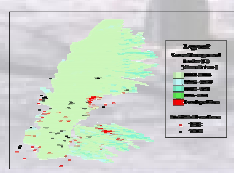


Figure 3. Pre-fire Cover Management Factor estimates for Enhanced USLE Approach

Results and Conclusions

Since much of the data used in both approaches were similar, such as the data layers for the Soil Erodibility (Figure 5) and Topographic Factors (Figure 6) there are some inherent similarities between the two approaches. For the pre-fire cases, the soil loss estimates made by the BAER Team and the Enhanced USLE Approach (Figure 7) both showed much lower soil erosion rates across the area later burned by the Cerro Grande Fire. However, a much larger proportion of the area had tolerable soil erosion (<2 ton/acre/year) using the Enhanced USLE Approach than that discovered by the BAER team. When the post Cerro Grande Fire soil erosion estimates were compared, several differences were observed

•the BAER Team post-fire estimates of soil loss were generally lower then the results from the Enhanced USLE Approach.
•the Enhanced USLE Approach pinpointed discrete areas needing conservation measures

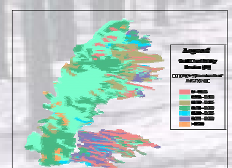
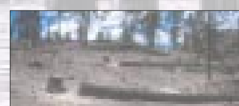


Figure 5. Soil Erodibility Factor estimates for Enhanced USLE Approach


Contour Felling

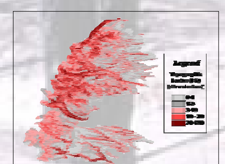


Figure 6. Topographic Factor estimates for Enhanced USLE Approach

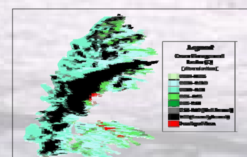


Figure 4. Post-fire Cover Management Factor estimates for Enhanced USLE Approach


Straw Wattles

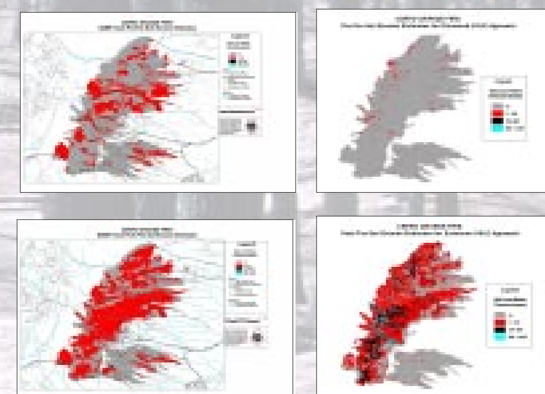
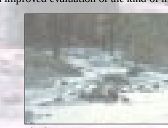


Figure 7. Soil erosion estimates made by BAER Team and Enhanced USLE Approach

Implications of Study

The soil loss estimates made by the Enhanced USLE Approach bracketed the BAER Team results, and gave a much larger range in soil erosion values, which we believe to be more realistic estimates based on comparable estimates of runoff currently being made by the Water Quality and Hydrology Group (ESH-18). We believe that the study results allow

•better spatial resolution of conservation measures that can be immediately applied to burned areas within the path of the Cerro Grande Fire.
•potential improvements on the methods used by future BAER Teams
•an improved evaluation of the kind of information that should be in a facility’s natural resources database


Flood Event

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